*Indian J. Phys.* **73B** (1), 105-109 (1999)

**NOTE**

**IJP B**

an international journal

# The effect of environmental variables on Cr and Pb in the brackish water wetland system

A Mitra[1], D P Bhattacharyya*[2] and A Misra[3]

[1]Department of Marine Science, Calcutta University, Calcutta-700 019, India
[2]Department of Theoretical Physics, Indian Association for the Cultivation of Science, Jadavpur, Calcutta-700 032, India
[3]Zoological Survey of India, Calcutta-700 016, India

*Received 20 July 1998, accepted 16 December 1998*

**Abstract** : Monthly estimation of total as well as weak acid leachable concentrations of Pb and Cr were done in the sediments around the Kulti river lock gate, the exit point of Calcutta wastes during March, 1996 to February, 1997 The dissolved Pb and Cr of the aquatic medium were also studied during the same period to investigate the process of compartmentation in the brackish water ecological system due to influence of salinity, pH and water temperature Multiple regression equations computed to analyse the effect of environmental variables on sediment Pb and Cr reveal considerable influence of salinity on the process of compartmentation of the selected heavy metals in the system.

**Keywords** : ecological system, multiple regression, heavy metals

**PACS No.** : 89.60.+x

The city of Calcutta with 100 municipal wards in the core area is sustaining about 11.86 million population. There are approximately 11,516 small and large factories in and around the city which produce toxic chemicals. Most of the effluents released from these factories are untreated which find their way into the Kulti river through city's main drainage system. The Kulti river lock gate, located 35 km south east of the city is the exit point of all the wastes of the city that generate due to multivarious industrial and anthropogenic activities. The area also enjoys the tidal impact of the Bay of Bengal through Matla and Bidya rivers which plays a great role on the speciation of the heavy metals present in the system. The salinity of the tidal water directly influences the species of the heavy metals present in the system [1] and thereby controls the process of precipitation and dissolution of the heavy metals [2] in the system.

It is now expected that the damage of aquatic community is mainly a function of weak acid leachable metal rather than the total amount of metal present in the river water or in

* E Mail : tpdpb@mahendra.iacs.res.in

sediments [3-4] and therefore the weak acid leachable metals were also assessed and given importance in the present investigation.

The Kulti river lock gate is located 35 km south east of the city of Calcutta and is the main discharge point of the important drainage system of the highly urbanised and industrialized city of Calcutta. The huge load of wastes generated from the city is released into this area from where they ultimately flow to the Bay of Bengal through Bidya and Matla rivers, respectively. Monthly sampling of surface sediments was done in the vicinity of the lock gate during March, 1996 to February, 1997 to estimate the load of total and weak acid leachable Pb and Cr in the sediment compartment. Before analysis each sample was dried overnight at 105°C in a ventilated oven, freed from visible shells, shell fragments or unwanted debris and crushed in a porcelain mortar to pass through a 0.45 mm nylon sieve. The determination of total metal content was done by treating 1 gm of the sediment with concentrated $HNO_3$, $HClO_4$ and HF [5] and weak acid treatment of the sediment sample with 0.5 N HCl [6] was done to determine the biologically available fraction or weak acid leachable portion of the total heavy metal concentration in the sediment. Analytical blanks were prepared and treated with the same reagents and all analyses were done in triplicate by direct aspiration into air-acetylene flame of Perkin-Elmer Atomic Absorption Spectrophotometer (Model 2380) equipped with a simultaneous background corrector.

The dissolved heavy metals were analysed by the same AAS following the standard methodology cited in [7] after filtering the sampled surface water through Nucleopore filter. The level of accuracy of the determination of dissolved heavy metals is indicated by unique agreement between our values and those reported for certified reference seawater materials (NASS-4 and CASS-2).

The surface water temperature of the sampling station was recorded with a celsius thermometer, the pH was recorded with a portable pH meter and the salinity was analysed with a refractometer which was later confirmed in the laboratory by argentometric method.

The inter-relationship between heavy metals in the ambient media and environmental variables *viz.* surface water temperature, salinity and pH was evaluated through a correlation matrix worked out using standard methodology. Multiple regression equations were also computed considering the weak acid leachable heavy metals of the Sediment as dependent variables in order to understand the synergistic or antagonistic role of environmental variables in the process of compartmentation of heavy metals in the brackish water wetland system at the exit point of Calcutta wastes.

Two regression equations of the following general forms were obtained for each of the weak acid leachable heavy metal in sediment :

$$Y_t = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 \tag{1}$$

where

$Y_t$ = biologically available or weak acid leachable heavy metal in sediment,

$b_0$ = constant,

$X_1$ = dissolved heavy metal in the ambient aquatic medium,

$X_2$ = pH of the surface water,

$X_3$ = salinity of the surface water,

$X_4$ = temperature of the surtace water.

The various *b* values are the partial regression coefficients.

In the present investigation, we have studied nine parameters at Kulti river lock gate area *viz.* surface water temperature, salinity, pH, dissolved Pb, dissolved Cr, total Pb and Cr concentrations in sediment and weak acid leachable available Pb and Cr from the collected sediment. Out of these, surface water salinity and pH exhibited a unique seasonal variations with highest values during the premonsoon months (March-June of the year) and lowest in the monsoon months (July-October of the year) as found from the Table 1.

**Table 1.** Monthly variations of physico-chemical variables at Kulti river surface water

| Month | Salinity (ppt) | pH | Surface water temperature °C |
|---|---|---|---|
| March, 1996 | 9.85 | 8.10 | 29.1 |
| April | 10.30 | 8.15 | 30.6 |
| May | 11.20 | 8.19 | 31.3 |
| June | 12.09 | 8.20 | 32.30 |
| July | 3.86 | 8.00 | 31.8 |
| Aug | 2.20 | 7.95 | 3 0 |
| Sep | 1.55 | 7.60 | 30.0 |
| Oct | 2.93 | 7.99 | 31.0 |
| Nov | 4.56 | 8.00 | 28.0 |
| Dec | 5.48 | 8.00 | 26.9 |
| Jan, 1997 | 6.83 | 8.08 | 25.2 |
| Feb | 7.95 | 8.10 | 26.1 |

The weak acid leachable Pb and Cr in the sediment exhibited a sharp seasonal trend as observed from the Table 3, but in the case of dissolved Pb and Cr in the aquatic phase a completely opposite seasonal oscillation was observed as the values of the recorded parameters displayed in the Table 2 were highest during monsoon and lowest during premonsoon unlike

**Table 2.** Monthly variations of dissolved Pb, Cr at Kulti river lock gate (*viz* Calcutta waste outfall region), 35 km away from the city of Calcutta during the period March, 1996 to February, 1997

| Month | dissolved Pb ($\mu g\ l^{-1}$) | dissolved Cr ($\mu g\ l^{-1}$) |
|---|---|---|
| March, 1996 | 82.3 | 58.4 |
| April | 62.8 | 39.6 |
| May | 59.5 | 20.6 |
| June | 52.6 | 41.1 |
| July | 81.0 | 66.7 |
| August | 99.1 | 91.8 |
| September | 101.8 | 95.6 |
| October | 137.3 | 111.8 |
| November | 120.6 | 107.0 |
| December | 91.2 | 80.5 |
| January, 1997 | 89.8 | 76.2 |
| February | 85.0 | 70.7 |

aquatic salinity, pH or weak acid leachable Pb and Cr in the sediment. The temperature of the surface water exhibited a bimodal peak with highest value recorded during premonsoon and lowest during postmonsoon. The total concentrations of Pb and Cr in the sediment, however, did not exhibit any seasonal trend and the distribution was totally mosaic in nature (Table 3).

**Table 3.** Monthly variation of total (1) and acid leachable (2) Pb and Cr (ppm.dry wt ) in the sediments near Kulti river lock gate.

| Month | Pb (1) | Pb (2) | Cr (1) | Cr (2) |
|---|---|---|---|---|
| March, 1996 | 9.8 | 4 1 | 5.6 | 3 6 |
| April | 10 1 | 3 9 | 7.8 | 3 8 |
| May | 7 3 | 4.3 | 6 9 | 4 0 |
| June | 8 0 | 4 8 | 5 2 | 4 2 |
| July | 6.9 | 3 2 | 4.9 | 2 8 |
| Aug | 11 2 | 2.8 | 3 9 | 2 4 |
| Sept | 5 6 | 2 1 | 4 1 | 2 0 |
| Oct | 13.1 | 2 9 | 8 0 | 2.6 |
| Nov | 10.8 | 3 0 | 6 6 | 2 0 |
| Dec | 6 5 | 3 6 | 4 3 | 3 0 |
| Jan 1997 | 6 9 | 3.1 | 5 0 | 2 8 |
| February | 8 8 | 3.9 | 5 8 | 3 3 |

Single correlation coefficients computed between the selected environmental variables (Table 4) indicate highly significant inverse relationship of weak acid leachable sediment metal with dissolved metal ($p<0.01$) and positive relationship with salinity ($p<0.01$) which reflects the process of sedimentation of heavy metals to be favoured by high salinity.

**Table 4.** Inter-relationship between the selected environmental variables :

| Combination | 'r'-value | 'p'-value |
|---|---|---|
| Acid leachable Pb × dissolved Pb | -0 79838 | < 0 01 |
| Acid leachable Pb × pH | 0 39061 | < IS |
| Acid leachable Pb × salinity | 0 93829 | <0.01 |
| Acid leachable Pb × temperature | 0 16432 | IS |
| Dissolved Pb × pH | -0 36189 | IS |
| Dissolved Pb × salinity | -0 82439 | <0 01 |
| Dissolved Pb × temperature | -0.23499 | IS |
| pH × salinity | 0 49180 | <0 05 |
| pH × temperature | -0.45960 | <0.05 |
| salinity × temperature | 0.07584 | IS |
| Acid leachable Cr × dissolved Cr | -0.85104 | <0.01 |
| Acid leachable Cr × pH | 0 38744 | IS |
| Acid leachable Cr × salinity | 0.97106 | <0.01 |
| Acid leachable Cr × temperature | 0.21174 | IS |
| Dissolved Cr × pH | -0.34243 | IS |
| Dissolved Cr × salinity | -0 86996 | <0 01 |
| Dissolved Cr × temperature | -0.29799 | IS |

IS means insignificant contribution

The highly significant negative correlations of dissolved heavy metal with water salinity ($p<0.01$) also proves that the process of dissolution of metal compounds from the sediment compartment to the aquatic phase is favoured by the lowering of water salinity in the brackish water ecosystem which is witnessed during the monsoon season in the state of West Bengal.

Multiple regression equations also indicate the dominant positive role of salinity as found from the Table 5 in the process of compartmentation of heavy metals.

**Table 5.** Multiple linear regression constant $b_0$ and coefficients $b_1$, $b_2$, $b_3$ and $b_4$ obtained from the expression (1)

| $Y_i$ | $b_0$ | $b_1$ | $b_2$ | $b_3$ | $b_4$ | $R^2$ | F (4,7) | 'p' |
|---|---|---|---|---|---|---|---|---|
| Pb | 2.8545 | -0 0011 | -0 1413 | 0.1913 | 0.0206 | 0 8907 | 14 258 | <0 01 |
| Cr | 0 9134 | 0 0032 | -0.0828 | 0.1996 | 0 0453 | 0 9663 | 50 153 | <0 01 |

**References**


[1] G W Bryan and H Uysal *J Marine Biol Assoc (U K)* **58** 89 (1978)

[2] Abhijit Mitra *J Indian Ocean Stud* **1** 49 (1993)

[3] M Waldichuk *Marine Pollut Bull* **16** 7 (1985)

[4] A Mitra, S Trivedi, A Gupta, A Choudhuri and A Choudhury *National Symposium on Aquaculture for 2000AD* (Madras Kamraj University, India) (1994)

[5] H Agemian and A S Y Chau *Analyst* **101** 761 (1976)

[6] B A Malo *Environ Sci Technol* **11** 277 (1977)

[7] L G Danielsson, B Manusson and S Westerluad *Analyt Chem. Acta* **98** 45 (1978)